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AUTOMATED DRONE CONTROL SYSTEM

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Abstract

The utilization of unmanned aerial vehicles (UAVs), commonly known as drones, has seen a significant expansion across various sectors, including surveillance, agriculture, logistics, and emergency response. This proliferation necessitates the development of sophisticated Automated Drone Control Systems (ADCS) to ensure efficient operation, coordination, and safety compliance. This study introduces an innovative ADCS framework that leverages advanced algorithms for real-time data processing, autonomous decision-making capabilities, and integration with existing information networks. By analyzing the performance of this system in simulated environments, we aim to demonstrate its potential to enhance operational efficiency, response time, and adaptability in dynamic scenarios.

Key words: *Unmanned Aerial Vehicles (UAVs), Automated Drone Control System (ADCS), Autonomous Decision-Making, Real-Time Data Processing, Information Networks.*

Introduction

In today's world, unmanned aerial vehicles (UAVs), commonly known as drones, are extensively used across various sectors – from agriculture and geodesy to search and rescue operations and delivery services. The increasing complexity of tasks performed by drones, as well as the necessity for their integration into broader information systems, necessitate the development of advanced control methods capable of ensuring autonomous operation, a high level of safety, and effective interaction among different drones. In this context, the development of an Automated Drone Control System (ADCS) emerges as a critical innovative task aimed at further advancement and optimization of UAV utilization across diverse activities.

The primary goal of ADCS is to minimize human intervention in the processes of mission planning, execution, and data analysis collected by drones. This involves the use of complex algorithms for automatic route planning, real-time sensor data processing, decision-making based on the analysis of gathered data, and managing the flights of a drone group with minimal operator involvement.

Significant interest in ADCS is also driven by the need to enhance flight safety, particularly through the automation of response procedures to unforeseen circumstances, such as changing weather conditions or the emergence of obstacles on the route. Additionally, the integration of drones into accepted information systems requires the development of standardized communication protocols and data exchange, which represents another research direction within the ADCS creation framework.

Thus, the development of ADCS stands at the intersection of many scientific and technological disciplines, including artificial intelligence, data processing, cybersecurity, as well as technical regulation and standardization. This opens up broad opportunities for scientific research and the development of innovative solutions aimed at expanding the capabilities of drone usage in society.

Overview

When developing software for automated drone control systems (ADCS), a comprehensive analysis and integration of several critical technical and operational parameters must be conducted. These parameters define the system's efficiency, safety, and reliability in dynamic and unpredictable environments. Here are the key elements that should be considered during development: **Flight Safety Aspects.** Ensuring reliable processing of input data from a multitude of UAV sensors is fundamental for obstacle detection, flight stabilization, and accurate navigation. The system must include mechanisms for autonomously responding to changes in conditions, such as worsening weather or loss of navigation system signals.

Energy Optimality. Algorithms for minimizing energy consumption by choosing the most efficient trajectories and regulating flight speed should be implemented. The software must adequately manage the limited energy resources of the battery, predicting operating time and optimizing energy distribution.

Autonomy of Actions. The integration of artificial intelligence and machine learning algorithms allows UAVs to independently recognize objects, make decisions, and adapt to environmental changes without operator intervention. In the case of using several UAVs, the software must ensure the synchronization of actions between devices to avoid collisions and optimize the overall mission efficiency.

Integration and Compatibility. A high level of integration with air traffic control systems, geographic information systems, and other external data sources must be ensured. The software architecture should be flexible, allowing easy addition of new features, integration of additional equipment, or adaptation to different types of UAVs.

Information Protection. It is crucial to implement robust protection mechanisms to ensure the security of communications between the UAV and the operator, as well as to protect stored data and software code. Advanced encryption methods should be used to protect transmitted data.

Developing an artificial intelligence algorithm that allows UAVs to autonomously recognize objects involves using deep learning and computer vision. Such an algorithm can be implemented through neural networks, specifically through Convolutional Neural Networks (CNN), which are the de facto standard for image recognition tasks. Here are the basic steps for developing such an algorithm:

1. Data Collection. The first step is to collect a large number of annotated images containing examples of objects that need to be recognized. These could be photographs of various objects from different angles and in different lighting conditions.

2. Data Preprocessing. The images need to be prepared for model training. This includes normalization (scaling pixel values), augmentation (applying random transformations to images to increase data diversity), and possibly object cropping.

3. Model Architecture Selection. Choosing the CNN architecture depends on the specific task. Popular architectures such as ResNet, Inception, or YOLO (for real-time object detection tasks) can be used as a starting point.

4. Model Training. The model is trained on the prepared dataset using the backpropagation algorithm. The training process involves optimizing the neural network's weights to minimize recognition error. Using regularization techniques, like Dropout, helps prevent overfitting of the model.

5. Testing and Validation. After training, the model is tested on a dataset that was not used during training to evaluate its ability to generalize recognition skills to new data. Assessing accuracy, recall, and other metrics helps understand the model's effectiveness.

6. Implementation and Optimization. The optimized and validated model is integrated into the UAV software. Further optimization may be necessary to reduce execution time and resource usage, especially for real-time use.

7. Continuous Learning. The development of the algorithm does not end with its implementation. Collecting data from real missions and analyzing it can be used for continuous improvement of the model**.**

Conclusions

Developing software for automated drone control systems requires an interdisciplinary approach that combines knowledge in aerospace engineering, computer science, artificial intelligence, and cybersecurity. Considering the above aspects is key to creating effective, safe, and reliable UAV control systems.

This approach allows the creation of a powerful artificial intelligence system for UAVs, which can effectively recognize objects in various conditions, enhancing the autonomy and operational capabilities of drones.

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